Charge polarization (dressed electrostatic interaction) effects in dusty (complex) crystals

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It is now established that the presence of massive mesoscopic (micron-sized, typically) particulates ("dust grains") may modify plasma properties substantially [1]. One of the most exciting novel features of dusty (or complex) plasmas is the occurrence of lattice (quasi-crystalline) configurations, due to the strong electrostatic coupling between dust grains. Inter-grain interactions in a dust crystal are generally thought to be of Debye-Hückel (Yukawa) "screened" type. However, refined theoretical studies have shown that taking into account plasma polarization due to the sheath region (near the grain surface) associated with the grains [2] results in a strong modification of the (oppositely charged) charge cloud surrounding the particles. This may eventually even allow for attractive (repulsive) interactions among equal- (opposite-)charge-sign particles.

The influence of dust charge polarization (dressing) on lattice vibrations is investigated in this brief report. Both uni-dimensional (1D) and hexagonal (2D) monolayer configurations are considered. It is shown that dressed interactions lead to a reduction in the frequency of lattice vibrations [3, 4], as regards both longitudinal and transverse degrees of freedom. The possibility of a new crystal instability (melting) entirely due to the dressing effect is pointed out. On the other hand, the occurrence of crystals consisting of opposite (...+-+-+-+...) charge dust grains may be anticipated via this mechanism [5].

References

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